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A
CHEMICO-PHYSIOLOGICAL
INAUGURAL DISSERTATION
ON
CARBONE.

D^r Nathaniel Piker

with Compliments from
the Author -

A
CHEMICO-PHYSIOLOGICAL
INAUGURAL DISSERTATION
ON
CARBONE, OR CHARCOAL.

SUBMITTED TO THE PUBLIC EXAMINATION
OF THE
FACULTY OF PHYSIC,
UNDER THE AUTHORITY OF THE
TRUSTEES OF COLUMBIA COLLEGE,
IN THE
STATE OF NEW-YORK:
WILLIAM SAMUEL JOHNSON, LL.D. President:

FOR THE DEGREE OF
DOCTOR OF PHYSIC;
ON THE FIFTH DAY OF MAY, 1795.

By WILLIAM MORREY ROSS,
Citizen of the State of New-Jersey.

—“Ea quæ scimus, pars minima eorum
Quæ ignoramus.”—
Præstat naturæ voce doceri quam ingenio suo sapere.

Late, when the mass obeys its changeful doom,
And sinks to earth, its cradle and its tomb,
— with nice eye the slow solution watch,
With fostering hand the parting atoms catch,
Join in new forms, combine with life and sense,
And guide and guard the transmigrating Ens.

DARWIN.

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—1795.—

23109



SAMUEL LATHAM MITCHILL, M.D.

*Professor of Chemistry and of Botany in Columbia College,
 Fellow of the Royal Society of Edinburgh,
 Foreign Associate of the Royal Society of Arts and Sciences at Cape
 François,
 Member of the Philosophical Society at Philadelphia,
 Of the Royal Medical, Chemical, Natural History and Physical
 Societies of Edinburgh,
 Secretary of the Agricultural Society of the State of New-York,
 &c. &c. &c.*

Who has ever manifested, during my residence with him, the most friendly attention, and given every assistance in forming the OUTLINES of my medical education; and who, it is hoped, will receive this *Inaugural Essay*, with all its imperfections, as a memorial of esteem and respect, from his friend and pupil,

Wm. M. ROSS.

THE HONOURABLE

JOHN CHETWOOD, *Esq*;

One of the Judges of the Supreme Court of the State of New-Jersey,
Esq. Esq. Esq.

Whose moral, intellectual and juridical endowments are
of established pre-eminence:

AND

AARON OGDEN, *Esq*;

In whom are united

The COUNSELLOR and the PATRIOT;

Will also receive this inscription as a respectful tribute to pre-
eminent literary, professional and patriotic merit.

The AUTHOR.

A

CHEMICO-PHYSIOLOGICAL
INAUGURAL DISSERTATION
ON
CARBONE, OR CHARCOAL.

THE following pages are divided into four chapters :

- I. The pure and simple substance of carbone, or charcoal, is treated of.
- II. Its natural and chemical history.
- III. Its œconomical uses; and,
- IV. The subject of carbone is considered *medically*.

CHAPTER I.

Of the pure and simple substance, carbone or charcoal.

CARBONE, or pure charcoal, is that substance which, in chemical nomenclature, is placed among the simple bodies, because no experiments hitherto made have proved that it is capable of decomposition.

It exists, ready formed, in the animal and vegetable republics, and also in the mineral, as is instanced in plumbago or the carburet of iron, &c.

Charcoal may be obtained from vegetable and animal substances, by incineration; but their subjection to *caloric*,

ric, or the *matter of heat*, must at first be moderate, and afterwards very strong; and for chemical purposes, the animal or vegetable substances containing it must be exposed, in a retort, to the heat of a reverberatory; by which means the substances capable of being volatilized, or all the parts of the subject susceptible of combination with caloric, evolve in the form of gas, and leave the charcoal and little earth or saline bodies, as being of a more fixed nature, in the retort.

This simple substance is capable of great durability, and not subject to decomposition like those of the compound ones, as is proved by its being found unchanged in the ruins of cities, decayed forests, &c. during the lapse of ages.*

Carbone is capable too, like many other simple substances, of combination with the *principle of acidity*, or *oxigene*: in the first degree of oxigenation, the *carbonous acid*, or *oxyd of carbone*, is produced; and if a sufficient proportion of *caloric* be added to this, it forms the *carbonous acid gas*, or the *gaseous oxyd of carbone*: in the second degree of oxigenation, the *carbonic acid* is produced, to which if a sufficiency of *caloric* be added, it is converted into *carbonic acid gas*.

CHAPTER II.

Its natural and chemical history.

CARBONE is the basis of that aëriform fluid which seems to have been first noticed and described by John
Baptist

* 3 Watson's Chem. Ess. p. 43.

Baptist Van Helmont; before whose time, Paracelsus, and authors previous to and cotemporary with him, thought this gaseous fluid to be the same with the air which we respire, although it does not appear they were authorised so to imagine or conclude, either by arguments, and much less by experiments. It was this elastic vapour that is evolved from bodies by combustion, fermentation and effervescence, that they caused to be named *spiritus sylvestris*.

To this *spiritus sylvestris*, then, as the predecessors of Van Helmont called it, he took upon himself to affix the name of *gas*, or *gas sylvestre*, which he defines to be “an incoercible spirit or vapour, which can neither be collected in vessels, nor reduced under a visible form.*”

This was the state of knowledge among the chemists of his time; since which, in modern days, according as it has been found combined with various substances, it has received different titles, such as *fixed air*,† *mephitic air*,‡ *fixible air*,§ *calcareous gas*,|| &c. By these appellations it was distinguished until the year 1770, when it was proved by Bergman to be an *acid*,¶ which has been more fully confirmed by Priestley. This discovery of Bergman has occasioned it to be known by the *cretaeous acid*, *mephitic acid*, *aerial* and *atmosphæric acid*.

B

That

* Helmontii Ortus Medicinæ, Cap. Complexionum atque missionum Elementalium Figmentum, No. 14.

† Dr. Hales.

‡ Mr. Bewley and Dr. Rutherford.

§ Falconer on fixible air.

|| Translator of Chemical Dictionary.

¶ 1 Bergman's Chem. Ess. p. 3.

That this substance is an *acid* was proved by our chemical professor——

1. Water impregnated with it, and agitated with the tincture of lacmus, or the litmus paper, turned them red.

2. By the precipitation of lime, from lime-water.

3. By water being highly charged with it, by means of Nooth's apparatus, which became manifestly acidulous to the taste.

4. By its neutralizing alkalies, and causing their crystallization.*

In a memoir to the Royal Academy of Paris, Lavoisier relates, he found by experiment, that a certain quantity of charcoal burnt in a given volume of vital or oxigene air, decomposed it, and produced a gas exactly similar to what is called fixed air, composed of charcoal, as an acidifiable base and oxigene, and which, according to his systematic plan, he called *carbonic acid*: but the matter does not rest on the synthetical experiments of Lavoisier, for Tennant decomposed the fixed air contained in marble, by the intervention of phosphorus into respirable air and charcoal;† however, as they did not appear altogether satisfactory, Pearson repeated them, and has shown, that although the compound affinities on which the result depended did not *necessarily* warrant the conclusion, yet his “well-imagined experiments have in our opinion,” say the reviewers,

* For a more circumstantial detail of the tests of its acidity, the elaborate work of Cronstedt may be consulted. (1 Cronstedt's Mineral. 2d edit. by Magellan p. 320, art. Acidum Aëreum.)

† See Month. Rev. vol. vii. new series, p. 71.

viewers, “ so fully established the decomposition of the fixed air, that we need no longer hesitate in adopting, for this fluid, the name of *carbonic acid*. ”

This gentleman employed the fossil and vegetable alkalies instead of calcareous earth, as the former contain, in their mild state, a greater quantity of the fixed air, and from their solubility in water the charcoal is the more easily separable. By following Tennant’s process with phosphorus in glass tubes, he obtained 100 parts of mild fossil alkali thoroughly dried, eight of charcoal in impalpable powder, intensely black, and so light that it occupied the volume of 22 times its weight of water. For the production of this quantity of charcoal, the alkali had lost so much of its fixed air as was equal, in its elastic state, to 20 ounce measures of water. When the deficiency of air was greater or less, the quantity of charcoal varied in the same proportion.

Quick-lime and caustic alkalies, especially the latter, can scarcely be so fully deprived of fixed air as not to exhibit, in this process, some vestige of charcoal: but alkalies saturated with vitriolic or marine acids yield none, and the quantity of charcoal is in all cases proportional to that of the fixed air contained in the subject and decomposed in the operation. Quick-lime which had undergone fire in a reverberatory during 48 hours, appeared free from fixed air, and yielded no charcoal: but the purest caustic alkali that could be procured was found to contain three ounce measures of fixed air to 100 grains, and gave a considerable quantity of brownish black powder, five times specifically heavier than

than the charcoal in the preceding operations, and of which only a small proportion was real charcoal.*

This acid, then, which is composed of *oxigene*, *carbone* and *caloric*, exists in nature in three different states:

1. In a state of combination with solid bodies.
2. In a state of mixture with fluids; and,
3. In a disengaged state of gas.

I. It was proved by Black, in 1755, that fixed air, or, as it is now called, carbonic acid, exists in a state of combination in lime-stone, which, on its disengagement, was converted into quick-lime; and this doctrine was supported by more facts from the experiments of Priestley, M'Bride and Jacquin, which last added still further proofs in confirmation, by proving that the causticity of alkalies and lime was owing to its absence.†

It exists too, not only in lime and alkalies, but also in stalactites, in the works of animals called corallines, madrepores, &c. and in their testaceous coats or coverings; and it is believed by some to be a mere congeries of water-worn shells, compacted together by the carbonic acid, that form the base of the island of Bermuda, which has thus become the habitation of man, plants and animals.

The Society Islands mentioned by Captain Cook, of which Otaheite is one, and which is said to be surrounded by coral rocks, seem, like the former, to have been

* Month. Rev. vol. x. p. 448. Phil. Trans. part ii. 1792.

† Pure carbonic acid for medical purposes is best procured from the Spatum Calcareum of Cronstedt, by means of the sulphuric acid; the other acids being not so proper, because of their volatility, &c.

been founded from the exuvial matter of animals; and these reefs may, like them, become also islands.

It has likewise been said, that carbonic acid is the vinculum of the human solid, which is especially asserted by M'Bride, who tells us he found it constantly produced on the decomposition of animal substances. No doubt he was right in recommending for seamen the use of malt-wort, from which, in its fermenting state, carbonic acid is plentifully evolved; the good effects of which wort were sufficiently proved in the voyage of Captain Cook, not one of whose men died of the scurvy alone: but yet his opinion of its efficacy being owing to the presence of carbonic acid, does not appear to prove *that* acid the vinculum of the living solid.

M'Bride seems to have been mistaken in the interpretation of his own experiments, by supposing, that our solids contained fixed air; whereas, on the contrary, our chemical professor proved, that the solids contain *not* the carbonic acid, but *merely* the elements, *carbone* and the *principle of acidity*, by which, on their decomposition, it may be formed.*

II. Carbonic

* The curious experiment by which our professor proved the composition of the muscular fibre was by means of the nitric acid: a piece of the fibrous or lean flesh of an ox being exposed, in a moderate heat, to the operation of this acid, there was a production of azotic gas, and a disappearance of the beef; on suffering the apparatus to cool, a greasy scum was found floating on the surface of the acid. In this experiment the nitric acid, by getting a surcharge of oxigene from the flesh, is rendered more capable of decomposing it, for then the azote, on being more easily disengaged, unites with caloric, and flies off in the form of nitrogene gas, which leaves the hydrogene and carbone of the flesh to combine in the oily pellicle, which, on cooling, floated on the surface. And thus are the lean and fibrous parts of animals convertible to fat.

II. Carbonic acid exists in a state of simple mixture in many mineral waters, from which mixture such waters derive the name of acidulæ, acidulous, or petrifying springs.*

The Saratoga springs, in the state of New-York, are especially remarkable for containing the carbonic acid in this state, which acid may very readily be collected in the form of gas, as is proved by the following experiments of Mitchill.

“ A young turkey, held a few inches above the water in the crater of the lower spring, was thrown into convulsions

Dr. Mitchill said too he had been in the habit of considering that the liver-oil of fishes was produced in the same way: during the spontaneous decomposition this organ undergoes in a moderate heat, there is an extrication of the azote, which leaves the hydrogen and carbone to form the oil, there appearing to be but little oxygene in the liver. Hence then the great firmness of flesh is owing to the very close affinity or attraction that the elementary substances oxygene, azote, hydrogen and carbone have for each other.

The muscular parts are not only decomposed artificially as in the above experiments, but also naturally.

Mr. Sneyd (Phil. Transf. for 1792, part ii.) gives an account of the conversion of a bird into a hard fatty matter. It was supposed to be a duck or young goose, and appears to have undergone its change by lying long buried in the mud of a fish-pond. The skin retains its original structure exactly, but is in great part separated from the flesh, though both are now composed of the same substance, which is in consistence like spermaceti, without taste or smell, melts in a small heat, though when congealed again, becomes more solid, and looks like wax. For Fourcroy's narrative of analogous changes in human bodies, in the cemetery DES INNOCENTS, see Annales de Chimie, vol. v. p. 154; European Magazine, for June, 1794; New-York Magazine, vol. v. p. 493; Chemical Nomenclature, by Professor Mitchill, p. 9.

* An account of a curious spring of this kind is related in the xxth vol. of the World Displayed, p. 182, the water of which seems likely to be iron oxydated by this acid, and perhaps with the addition of a little clay, forming one of the ochres of that metal. In other kinds of petrifying springs, bird's nests, leaves of trees, &c. have been found inclosed in the midst of petrifications.

convulsions in less than half a minute, and, gasping, shewed signs of approaching death; but on removal from that place and exposure to the fresh air, revived, and became lively. On immersion again for a minute in the gas, the bird was taken out languid and motionless.

“ A small dog, put into the same cavity and made to breathe the contained air, was, in less than one minute, thrown into convulsive motions—made to pant for breath; and lastly, to lose entirely the power to cry or move: when taken out, he was too weak to stand, but soon, in the common air, acquired strength enough to rise and stagger away.

“ A trout recently caught, and briskly swimming in a pail of brook-water, was carefully put into a vessel just filled from the spring: the fish was instantly agitated with violent convulsions, gradually lost the capacity to move and poise itself, grew stupid and insensible, and in a few minutes was dead.

“ A candle, repeatedly lighted and let down near the surface of the water, was suddenly extinguished, and not a vestige of light or fire remained on the wick.

“ These experiments nearly correspond with those usually made in Italy, at the famous Grotto del Cani, for the entertainment of travellers, as mentioned by Keyser, Addison, and others.

“ A bottle filled with the water and shaken, emits suddenly a large quantity of ærial matter, that either forces out the cork, or makes a way beside or through it, or bursts the vessel.

“ A quantity

“ A quantity of wheaten flour, moistened with this water and kneaded into dough, when made into cakes and put into a baking-pan, rose, during the application of heat, into light and spongy bread, without the aid of yeast or leaven. From which it appears, that the air extricated from the water is precisely similar to that produced by ordinary fermentation.

“ Some lime-water, made of stalactites brought from the subterranean cave at Rhinebec, became immediately turbid on mixture with the spring-water; but when the water had been lately drawn, the precipitate was quickly re-dissolved.

“ Some of the rock surrounding the spring, on being put into the fire, calcined to quick-lime, and slacked very well.

“ When the ærial matter has evaporated, the water loses its transparency and lets fall a calcareous sediment.

“ Whence it is true, that the gas is ærial acid, that the rock is lime-stone, and that by means of the former, the water becomes capable of dissolving and conveying the latter.”*

III. The other form in which carbone exists in connection with the principle of acidity and the matter of heat, forming carbonic acid gas, is in subterraneous grottos, caverns, mines, &c. where it has received, from its deleterious qualities, the name of choak-damp, &c.

It is extricated in this state from wine, mead, verjuice and bread, and from vegetables during combustion and fermentation, as was long ago known to Van
Helmont,

* Morfe's Geog. vol. i. p. 457.

Helmont, who asserts, that it is by means of the corruption of the aliment, and to the evolution of this gas, that we should ascribe the flatus, &c. in the alimentary canal.*

Carbonic acid gas is evolved too during respiration, as may be easily proved by passing our breath through lime-water, which it instantly turns turbid.

These are not the only observations of Van Helmont on this gas, for he has mentioned it in several other places, and particularly in his treatise *de Lithiasi*. cap. iv. No. 7. and in his *Tumulus Pestis*.

The properties of the carbonic acid are :—

1. When it is in a state of simple mixture or combination with water, it is destructive to the lives of fish, being unfit for their respiration, as was proved not only by Mitchill in his experiments on the Saratoga springs, but also on another species in the presence of the chemical class.

That it is alike noxious to the respiration of plants, when they are exposed to too great a quantity of it, is sufficiently evinced by Priestley's experiments.

The medical properties of this acid are remarkably evident from the effects of the saline draughts of Riverius, from Seltzer water, and from the employment of yeast in the New-York hospital.

2. That in its gaseous state it is unfit for animal respiration in air, has been long ago observed, as we find in history, which informs us that the two slaves

C

Tiberius

* Tractat. de Flatibus, No. 67 and 68, Persius, Sat. iii. 99.

Tiberius Cæsar commanded to descend into the Grotto del Cano were immediately suffocated.

And it is to this gas that Van Helmont,* Morgagni,† Hales,‡ and Addison§ attribute the fatality of those who enter the above Grotto, and especially Van Helmont, who conceives it to be entirely owing to this vapour that danger is always present in cellars containing fermenting ale, cider, &c. and Pliny speaks also of caves from which deadly exhalations arise; “and in the territories of the Hirpines,” says he, “there is that of Amsanctus, a cave near to the temple of Nephites, into which as many as enter suddenly die.”||

The deadly effects of the vapours of charcoal, or the carbonous acid, when applied to our respiratory organs, were sadly experienced a few years ago in New-Jersey, and many other cases of the like kind have been related.¶

The famous lake of Averno too, in which Virgil tells us is the entrance of the Pandemonian regions, is said to have exhaled so great a quantity of this elastic fluid, as to have killed birds that attempted to fly over it.**

CHAPTER

* Compl. atque Mist. Element. Figm. No. 43.

† De Sed. & Caus. Morb. Epist. 19.

‡ Statics, 260, 261.

§ Vol. iv. p. 139. See also curious experiments on the same Grotto, related in 3 Keyser's Travels, p. 114; 3 Grand Tour, (by Nugent) p. 404; Encyclopæd. Brittan. art. Grotto; Tours by Brydone, Moore, &c.

|| C. Plinii Nat. Hist. tom. 1. lib. ii. Cap. xciii. De Miraculis Terrarum.

¶ L. Annaei. Senecae ad Lucilium Nat. Quæst. lib. vi. 28. In quo de terræ motu agitur. Mead. de Venenis, tent. 6. 4 Hoffman, p. 697. No. 22. x Percival, Ess. vi. &c.

** Virg. Æn. vii. l. 82.—Æn. vi. l. 237, & Notæ. This, however, does

CHAPTER III.

Æconomical uses of carbone and its compositions.

1. CHARCOAL is used in the composition of gun-powder, and the purer it is, the stronger and better will be the powder. Charcoal, which is generally produced by the incineration of vegetables, and used for this purpose, and which approaches nearest to chemical exactitude, is said to be procured from the *Corylus* of Linnè. It is used in gun-powder because of its great combustibility, which is derived from its colour and natural attraction for oxygene; for the carbone first decomposes oxygene air, which produces that temperature in which the sulphur becomes also capable of the same process, and both these more effectually by the great quantity of oxygene the nitre affords.

The chemical affinities of the ingredients of gun-powder may be understood by the following table:—

Gun-powder,	{	Nitre,	{	Pot-ash.	{	Azote,
		Sulphur.		Nitrous Acid,		Oxigene.
		Carbone.				

These ingredients in and after explosion form other compounds, according to their respective chemical affinities:—

Oxygene

not appear to be the case now, as Silius Italicus (lib. xii.) informs us that the noxious vapours which issued from Lake Averno in the days of Hannibal were entirely dissipated by the free accession of air since the felling of the woods that surrounded it by the order of Agrippa.

Oxigene and Sulphur	form	Sulphuric Acid.
Sulphuric Acid and Pot-ash		Cubic Nitre.
Oxigene and Carbone		Carbonic Acid.
Carbonic Acid and Pot-ash		Mild Alkali.
Azote and Caloric		Azotic Gas.
Pot-ash and Sulphur		Hepar Sulphuris.
Azote and Oxigene (1st degree)		Oxyd of Azote.
Oxigene and Caloric		Oxigene Gas.

Hence then, from these new combinations taking place, we easily understand that the explosive force of gun-powder no longer remains a problem in chemistry, as it is demonstrated to depend upon the formation and extrication of different gasses, and that as the ingredients of the gun-powder bear to each other an exact ratio of proportion, will its strength and explosive capacity be increased.

The other new combinations that are formed and become more fixed, are also easily comprehended, for we find that in instruments wherein this composition is exploded there remains a residuary foetid compound, which appears to be the sulphure of pot-ash, coloured by means of the charcoal, &c.

Father Kircher says,* we ought to attribute the discovery of the above composition to Barthold Schwartz, or Barthold the Black, a monk of Goslar, in Germany, a man of profound knowledge in alchemy. This man having made a medicinal mixture of sulphur, nitre and charcoal, it happened that a spark fell into it, and caused it to explode with the most dreadful violence. This so astonished the monk that he

* *Mundus Subterraneus*, p. 487.

he repeated the experiment, and more fully discovered the nature and properties of gun-powder in 1354.

The invention of gun-powder seems also to have been attributed to the same German by Polydore Vergil,* who thinks him too ignoble to have his name handed down to posterity.

The composition of gun-powder by some, however, is supposed to be of more ancient date, for Lord Bacon says ordonance had been used in China 2000 years ago.†

——“ Taught mysterious Bacon to explore

“ Metallic veins, and part the dross from ore;

“ With sylvan coal in whirling mills combine

“ The crySTALL'd nitre, and the sulphurous mine;

“ Through wiry nets the black diffusion strain,

“ And close an airy ocean in a grain.”‡

Charcoal is also used in the *arts*, for the purpose of disoxygenating bodies, and especially by metallurgists, who are thereby assisted in the assaying of ores, and reducing them to their reguline or metallic state.

* Polyd. Verg. de Inven. Rerum, lib. ii. cap. 11.

† Essay on the Vicissitudes of Things. For a more full account of the composition of gun-powder, see Watson's Chem. Ess. vol. i. p. 327.

‡ Gun-powder is plainly described in the works of Roger Bacon before the year 1267. He describes it in a curious manner, mentioning the sulphur and nitre, but conceals the charcoal in an anagram. The words are, sed tamen falis petræ LURE MORE CAN UBRE et sulphuris; et sic facies tonitrum, et corruscationem, si scias, artificium. The words lure more can ubre are an anagram of carbonum pulvere. Biograph. Brit. vol. i. Bacon de Secretis Operibus, cap. 11. He adds, that he thinks by an artifice of this kind Gideon defeated the Midianites with only three hundred men. Judges, cap. 7. Chamb. Dict. art. Gun-powder. As Bacon does not claim this as his own invention, it is thought by many to have been of much more ancient discovery. Darwin Cant. i. l. 237. 1 Watson's Chem. Ess. p. 335.

state. It is this simple substance too, on its exilition in the gaseous form from the alkali, that makes the sudden explosion in *Pulvis fulminans*, when the sulphur and alkali combine, and form a hepar or sulphure which is coloured by the charcoal.

2. In a state of combination with the carbonates of lime, such as chalks, marbles, lime-stones, marles, testaceous shells, &c. it is used for agricultural purposes,* and appears to be a natural and considerable stimulant on the absorbent system of vegetables, enabling them to take in a greater quantity of nourishment and to become more vigorous; and our professor of agriculture † delivers it as his opinion, that the carbonates of lime act pretty much like the gypsums, not so much by yielding nourishment themselves, as by operating on the excitability of plants, giving them greater appetency for food, strengthening their digestive powers, and thereby enabling them to grow with increased energy and luxuriance. And it seems to be that lime which, in its caustic state, is scattered over fallow land by farmers, becoming carbonated or neutralized by this acid, that affords that wholesome stimulus to the future crop; for, were this not the case, the lime would soon destroy them, as it is well known to do both vegetable and animal substances in its state of purity or causticity; though even in this state it may be advantageously employed in some cases to quicken the decay or decomposition of dead vegetable matter, as in dung-heaps, &c.

The

* Fordyce's Elem. Agric. Anderson. Agric. Kaimes' Gent. Farm. &c. &c.

† Mitchell.

The carbonic acid not only appears to be a considerable stimulant to vegetables, but they would also seem to decompose it, for the purpose of receiving its base into their constitutions, and this seems countenanced from what has been related concerning the experiments of Myer.*

Although it has long been disputed by chemists, physiologists and agriculturalists, whether or not charcoal existed, and was formed naturally by the vegetable œconomy; yet, from these late observations it is found true beyond doubt, that it is a substance procured *ab extrâ*, and when taken in becomes an ingredient in the ligneous part of the vegetable:† and by this mean may vegetables purify the atmosphere, not only by their extrication of vital air, but also by decomposing the carbonic acid or its gas: and hence we perceive that this acid is decomposed naturally as well as artificially, when in the former it goes to combine with the hydrogen of the vegetable, and thus forms their oils and resins, &c. it being to be considered, that the most valuable manures contain very large proportions of a carbonaceous substance, as in swamp manure, cow-yard manure, &c. and that the exhaustion
of

* Muhlenberg's Letter to Mitchill on the cultivation of the *AVENAE* ELATIOR—GYPSUM and STONE COAL as a manure, &c. Transact. Agric. Soc. of New-York, for 1794, part ii. p. 215. See an experiment to the same effect made by Senebier, related in 3 Chaptal's Chem. p. 32, and by Hassenfratz, Annales de Chimie. Month. Rev. new series, vol. xi. p. 540.

† This appears to be the case especially with the *SPHAGNUM PALUSTRE* of Linnè, which is of so entirely a carbonaceous structure as to continue for a great length of time undecomposed, when covered with strata of earth, as may be seen near New-Town, on Long-Island, &c.

of the fertility of soil in 'old cleared land is owing in a great degree to the consumption by vegetable absorption of that carbonaceous stratum of dead leaves, decayed and rotten trees, &c. which, on the first settlement of the country covered the surface of it. And the fertility of all our lands appears to be in a considerable degree owing to the leading ingredient—carbon.

3. In a state of mixture with water; and, 4thly, in a state of gas it may be used œconomically in the making of bread, as Mitchill not only proved in the experiments at Saratoga, but also in a state of gas, as appears by the following extract:—"Why are barm, yeast and leaven, and other like substances, necessary to raise fermentation in bread? It is not necessary that bread undergo fermentation in order to be good; but it is simply requisite that a quantity of fixed air should be extricated to raise and puff it up. This divides and parts asunder the dough, and renders it porous and soft, prevents excessive toughness and hardness, and makes the bread easy to be broken, cut and eaten: further, fixed air, although a poison when applied to the organs of smell and respiration, is an agreeable stimulus when taken into the stomach, and may operate, when an ingredient in bread, just as it does in porter and other malt liquors. What good does pot-ash do in cakes? Pot-ash contains a great portion of fixed air, which is set at liberty by the heat necessary to bake the cake; and therefore pot-ash supercedes the use of fermenting mixtures. How is the water of Saratoga spring useful? In the same manner. The water

is decomposed by the heat, lets go the fixed air, which insinuates itself into the bread, and causes it to be light and spongy. For what reason are holes pricked into loaves of bread? The heat of the oven not only sets free a large quantity of fixed air, but also greatly rarifies it: if, therefore, there be no outlet given to it, the loaf would be bursted in an unsightly manner, or an extensive blister would be formed beneath the upper crust, to the damage of the bread.”*

Carbonic acid may not only be œconomically applied in the making of bread, but also from late observations in the making of vinegar, as appears from the experiments of Chaptal, who, by means of water being impregnated with near about its own bulk of this acid, and exposed in a cellar where it had free ventilation, found all that was contained in the vessels in a short time converted into acetous acid; and as there appears to be nothing wanting but a presence of hydrogen gas, and that particular temperature in which this change may be wrought, it is not improbable that in time this will be found a very cheap, easy and expeditious way of supplying ourselves with this article.

It has been suggested by Percival as deserving trial by florists and horticulturalists, when combined with water;† and from what has been said on the agricultural use of lime, &c. modified by this acid, it would seem very likely to produce good effects, as the acid may be decomposed in his experiments as well as in those above related.

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CHAPTER

* See “Sketch of the Philosophy of House-keeping,” &c. American Museum for October, 1790, p. 179.

† 2 Med. Ess. p. 147.

CHAPTER IV.

The subject of carbone considered medically.

IF it be true that the substances composing the sanguineous, nervous and muscular parts of our constitutions shall at different times exist in greater or less proportion, or possess greater or less attraction for each other than is consistent with the health and well-being of our bodies; it follows, that when there shall be an absence or surplussage of one or more of the ingredients forming the compound, the substance or substances so absent, or if they are present and exist in a too great or small quantity, that disease must be induced corresponding to the present ingredients and their tendency to form new combinations: and hence it appears, that the materials forming our bodies must exist in a certain ratio of proportion with regard to each other, in order to constitute health; every departure from which ratio will produce predisposition if not actual disease.

That disease sometimes arises from a disproportion of the ingredients or materials forming the blood and the muscular compages of our flesh, will be sufficiently apparent by attending to the phænomena that are chiefly conspicuous in the symptoms of the two diseases of phthisis and scorbutus, or consumption and scurvy: the former to be considered as depending upon or occasioned by an *excess*, and the latter by a *deficiency* of the oxygenous principle; accompanied in the former with a *diminution*, and in the latter with an *increase* of the carbonaceous

carbonaceous material.—And first then of *Phthisis pulmonalis*.

PHTHISIS.

FOR the better explanation of the symptoms of this disease, we shall consider it under the three following heads, which are perhaps as just characteristics as any of the complaint.

- I. The remarkable loss of fat, and often of muscular substance apparent in it.
- II. That happiness, cheerfulness and serenity of mind which attend it: and,
- III. The fever for which it is remarkable.

I. The remarkable loss of fat and often of muscular substance that is manifested in consumption, even to the extreme leanness so conspicuous in the *facies hippocratica*, may probably be explained on the supposition of an *excess* of the acidifying principle in the following manner:—The oxigene may unite with the carbone of our flesh, during the temperature of the system occasioned by means of the fever, which increased degree of heat causes a greater attraction of the carbone for the oxigene than before existed, and by uniting with it and caloric, flies off in the form of carbonic acid gas, and takes away the basis of the muscles and fat: the basis of the flesh, being thus dissipated, leaves the other ingredients in greater attractive force * for each other than they

* “ CARBONIC MATTER long since presented itself to my mind as likely to be serviceable in diseases, where we should desire to deprive the system of oxigene. Its great attraction for oxigene, in high temperatures, has long been known; and the experiments of Mr. Lowitz, and still more the very surprising ones of Dr. Kels, (CRELL'S ANNALEN, ft. 3. 1792) and of Dr. Buckholz,

they possessed before; so that they also may unite and form new combinations, as part of the hydrogen may combine with the carbonic acid during its formation and evolution from the surface of the body, and form that colligative or clammy sweat which is so constant a debilitant in consumption. Part of the hydrogen too, may combine with the oxygen, and produce the dropical swellings sometimes observable in that complaint; and most other atrophial diseases, whether they arise from defect of nourishment or from mesenteric obstructions, may, like the consumption, be owing to a deficiency of the radical of the carbonic acid; and it would seem to be by this combination of oxygen, carbone and caloric flying off in the form of gas, that occasions emaciation, not only in this complaint, but in all fevers whatsoever.

II. The serene and cheerful disposition which patients in consumption almost always possess, may also be owing to an excess of the same principle; and it may not be unlikely, that it acts immediately on the *vital solid, or living moving powers, which appear to be so delicately organized, and to possess that peculiar excitability, capacity, or susceptibility of impression*, that when oxygen, its *natural* stimulant or excitant, shall be applied, an effect or an excitement is produced; which *quality*, thence arising from effects so produced, is what is

(GREN'S JOURN. DER PHYSIK. B. v. p. 3.) shew that at a temperature considerably below that of warm-blooded animals, carbonic matter is by no means so inert a substance as it has hitherto been reputed. Dr. Moench (V. D. ARZNEY-MITTELN, p. 221.) assures us, that he has given it largely with success."

Beddoes' Letter to Darwin, p. 68.

is called Life; and in proportion as such application shall be made and continued, will be the effect and continuance of this pleasant quality in the system, as is instanced in all the intermediate degrees of the state of mind in scurvy and consumption.

But this *quality, aptitude or relation* which the vital solid possesses of being operated upon by its *natural* stimulant, oxigene, may at length be worn out of its excitability, as is proved by animals being exposed to an atmosphere of pure vital air, who shortly after died; not from the irrespirability of the air, for animals could live in it afterwards, but from this *animal capacity* being destroyed by means of the indirect debility the gas produced on their systems; and hence the above quality must cease, and cessation of life, or death as it is called, must ensue. Therefore *excitement*, which is an *effect* produced by the above exciting power, acting upon the excitability of the vital medullary system and irritable fibre, and which is commonly called life, or the vital principle, would not seem to be a *distinct substance* added to the body, but merely the modification or organization of the component atoms in a specific manner, and with due proportions of each of the elements; which organization and proportion are conditions necessary to life, and the destruction of which in all cases produces or accompanies disease or death:— This then, this is the *magnum arcanum naturæ* in this case of animated existence; that animals, when this *quality* shall cease to exist, *die—to be succeeded by other animals; and that the same materials that formed the one animal,*

animal, may, after its death, go to the formation of another.

That the cheerful disposition of mind in consumptive patients is occasioned by a super-oxygenated system, would seem as fully rational and conclusive as that of the great Haller, who would feign believe that this state of exhilaration, wherein the bodily powers were wasting away by disease, manifested a "*certain somewhat*," which argued an immortality of the soul.*—However, were we to form a just and accurate conclusion from the facts and observations above related, we could not be led to an explanation of the cause of that "*certain somewhat*" which occasions hilarity in these patients, as Haller has done; but, we must consider *life as an effect produced by the action of stimuli, and particularly of the oxygenous principle, upon the excitability of the muscular and nervous system; and hence, that it is not a principle, but a condition—not a substance, but a quality of a substance.*

That it is the *oxygenation* of the system which occasions the above *quality* or disposition of mind, and that this will be effected in proportion as the system shall be so oxygenated, will not only appear from the cheerfulness it inspires on breathing it, but be made further apparent hereafter, when the symptoms of a disease supposed to be induced from *disoxygenation*, or a *deficiency* of the same principle, shall be taken into consideration.

It

* viii. Haller. Element. Physiolog. lib. xxx. § 23. Signa Mortis.

It may not, however, be deemed improper to adduce here another argument in support of what has already been said concerning the exhilaration of mind in consumption, which appears to be dependant on the same cause, and existing in proportion to the degree it shall be applied; it is this, that in general females are remarked to be more subject to this complaint than males; so also it is well known they possess greater irritability, that their imagination and vividity of thought far exceed those of males; all of which symptoms are clearly the effects of their systems being comparatively oxygenated in a greater degree than the males; and this is remarkably illustrated by an observation made by Pliny, who says, “The blood of males is commonly blacker than that of females;”* which change of colour Priestley has long ago proved to be owing to the influence of oxygenous air.

Since then it is the principle of acidity that enters and becomes part of the solid substance of our bodies, and occasions that stimulation on the excitability of our nervous systems, &c. which produces the phenomena of a living state, we may with great facility explain many of its functions, which seemed formerly to have eluded the observations and researches of the most diligent physiologists: we have already explained some of the most difficult, that at first sight seemed to have been inscrutable; and the other powers that follow, distinguishing dead from living matter, are the internal stimuli themselves; “the functions of the system itself
producing

* Nat. Hist. tom. i. lib. 11. cap. 38.

producing the same effect are muscular contraction, the exercise of sense, the energy of the brain in thinking, and in passion and emotion." These, together with the external stimulant power of oxigene after its application, produce the same effect, and life, or the quality of animation, is therefore found to be *excited* by their mutual co-oprance; and hence "*is a forced state of existence.*"

This consequent performance of functions, when the stimulus of oxigene shall be applied to a system, possessing a *capacity* of being roused to life, will also probably explain, among other of its functions, the circulation of the blood, without accounting for it on the sole action of the heart, or ascribing it chiefly to the effect of muscular fibres, by some supposed to exist in the vascular system: on the contrary, it would appear to be almost entirely explicable on the above supposition: and indeed, though the heart or muscular fibres should be admitted to have a tendency to aid the circulation of the sanguineous fluid, yet this appears to be only in proportion as the blood shall be oxigenated, and thus operate on their excitability: and that they have no such great agency is further demonstrated by the circulation existing in a human creature born without heart or lungs, wherein the circulation between the fœtus and the mother continued by means of the umbilical cord and placenta, so as to stimulate the arteries to action, until, after birth, when the cessation of the oxigenating process,*

* ——— "The fœtus has its blood oxigenated by the blood of the mother through the placenta. During pregnancy, there seems to be no provision for the reception of an unusual quantity of oxigene. On the contrary, in conse-

process, on account of the want of respiratory organs, was directly followed by death.*

It is also probable, that oxigene is the cause of irritability, from this quality being greatest in parts where most blood is sent; and where this is abstracted, the vital principle, as Hunter calls it, must also cease, as he proved by his experiments in the bleeding of animals: and, on the contrary, where there shall be less sent, or where it shall lose the property of being arterial, those parts will be less sensible, as is evidently perceived in the liver, &c.

Animals too, possessing a great quantity of oxigene, are also most irritable, as is perceived in the tortoise, which will exceedingly well apply to prove that the circulation of the blood is carried on by the means above stated: for Mitchill relates an experiment made by himself, wherein, after withdrawing the blood and injecting water in its place, he found that the heart

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would

quence of the impeded action of the diaphragm, less and less should be continually taken in by the lungs. If, therefore, a somewhat diminished proportion of oxigene be the effect of pregnancy, may not this be the way in which it arrests the progress of phthisis? and if so, is there not an excess of oxigene in the system of consumptive persons? and may we not, by pursuing this idea, discover a cure for this fatal disorder?" Beddoes' *Observ. on Calculus*, &c. p. 114, 116.

He goes on further to say, that "pregnant women agree with scorbutic patients in that strong instinctive appetite for vegetables; and it appears as if this diet was the most suitable to them."

"Pregnant women," says Dr. Denman, "have generally a dislike to animal food of every kind, and under every form—on the contrary, they prefer vegetables, fruit, and every thing cooling, which they eat and drink with avidity, and in which they indulge without prejudice." *Introduct. to Midw.* p. 243. See *Review of Beddoes' Observations*, &c. 8 *Duncan's Med. Com.* p. 79.

* See a Description of a Human Male Monster, by Dr. Monro, iii. *Trans. Roy. Soc. Edin.* p. 215.

would contract and propel the water for some time, until, for want of a fresh supply of oxigene, it stopt. This irritability is well known in the eel, turtle, &c. and many of the class of amphibia of Linnè.

Oxigene, however, may not only be the cause of irritability in the instances already mentioned, but may also produce this quality in vegetables, as in the *mimosæ*, &c. and in all organized matter whatsoever possessing a *capacity* of being operated upon by it.

III. The fever which attends consumption would also seem to be confirmative of the above doctrine, and will perhaps be of extensive application to the explanation of fever in general, especially that of the synocha, in which a phlogistic, or what perhaps would be a more accurate expression, an oxygenated diathesis of the blood, exists to so great a degree that phlebotomy is often employed to decrease the action of the heart and arteries.

That fever is occasioned by an excess of this principle has been fully proved by the exposure of animals to an atmosphere of oxigene air, when they have shewn all the diagnostics of fever and inflammation. This then being the fact, we can easily understand why phthisis is attended with fever, since it is evident, that super-oxygenation is the cause of the complaint; for the oxigene, on account of its great attraction for caloric, always carries a great quantity of it in a combined state; and this oxigene itself may perhaps be decomposed by means of the vital solid, and thus not only produce irritability, but also occasion a greater evolution of its
heat

heat from a state of combination to that of a liberated form; thus constituting febrile heat, which produces that degree of temperature in the system, by means of which the oxigene, &c. will the more strongly be attracted by the materials composing the adipose and muscular parts of our bodies, and thus, by forming new combinations, fly off in the form of gas, and produce, in part by these effects, the diminution of bulk and strength that is observed in fevers, especially those that are terminated by colliquative sweats; and it is this thermometric heat passing again to a latent state in the perspiratory matter on the surface of the body that in some cases occasions the sensation of chilliness and coldness of which patients complain.*

Inflammatory

* Since writing the above, Beddoes' letter to Darwin, on the subject of "a new method of *breathing* preventing pulmonary consumption," has come to hand, from which the following extract is selected, that the reader may draw such inferences as may be suggested from a comparison of what has been delivered with the experiments of that celebrated physician:—

"After securing a full supply of oxigene air, the first thing I undertook was to attempt to throw some light upon the nature of consumption by an experiment upon myself. Not having any thing of the phthical conformation or the slightest hereditary claim to the disease, I thought I might venture very far in oxigenating myself without any great risque; and it was impossible for me to observe the effects so minutely in another person. I accordingly respired air of a much higher than the ordinary standard, and commonly such as contained almost equal parts of oxigene and azotic air, for near seven weeks, with little interruption. I breathed it upon the whole sometimes for twenty minutes, sometimes for half an hour, and sometimes for an hour in the day; but I never continued breathing for above four or five minutes at any one time. I felt, at the time of inspiration, that agreeable glow and lightness of the chest, which has been described by Dr. Priestley and others. In a very short time I was sensible of a much greater flow of spirits than formerly, and was much more disposed to muscular exertion. By degrees, my complexion, from an uniform brown, became fairer and somewhat florid. I perceived a carnation tint at the ends of the fingers, and on all the covered parts of the body the skin acquired

Inflammatory fevers prevailing most generally in northern and less in southern climates, may also possibly be owing to the system having greater opportunity of becoming furcharged with oxigene and caloric in the former than in the latter, and if so, consumptive patients will grow better in a warm than in an opposite state

much more of a flesh colour than it had before. I was rather fat, but during this process I fell away rapidly, my waistcoats becoming very much too large for me; I was not sensible, however, of my muscular emaciation, but rather the contrary. My appetite was good; and I eat one-third or one-fourth more than before without feeling my stomach loaded. In no long time I observed in myself a remarkable power of sustaining cold. Except one or two evenings when I was feverish, I never once experienced the sensation of chilliness, though cold easterly winds prevailed during great part of the time I was inspiring oxigene air. I not only reduced my bed-clothes to a single blanket and cover-lid, but slept without inconvenience in a large bed-chamber, looking to the N. E. with the window open all night, and with the door and windows of an adjacent sitting room also open. About the expiration of the above-mentioned time, I perceived some suspicious symptoms. It was uncomfortable to me to sit in a room at all close. I frequently felt a sense of heat and uneasiness in my chest; and my skin was often dry and hot, with burning in my palms and soles; my pulse, which had hitherto seldom exceeded eighty, was above ninety in the evening. At this time I took a journey of about 170 miles, the greater part in a mail coach in the night, the rest on horseback. The roads were uncommonly dusty, and several circumstances concurred to harass and fatigue me. On the way I met with a medical friend, who was much struck with the flushed appearance of my countenance; and upon feeling my skin and pulse, which varied from an hundred and four to an hundred and twenty, imagined that I was become hectic. I had now, though but seldom, a short, dry cough; but the sense of irritation to cough required an almost constant effort to suppress it: this sense of irritation was, as you will suppose, attended by dyspnœa. I had also frequent bleedings at the nose, an event almost unprecedented with me; the blood was of an unusually bright colour; which was also seen in blood forced from the gums. Whenever I pierced the skin in shaving, the blood flowed in greater abundance than usual, and was staunched with difficulty."

In confirmation of what is related in the above case, and of the injurious effects of vital air in consumption, may be added Fourcroy's relation of the cases of twenty patients in this complaint, whom he caused to respire oxigene gas. Beddoes' Obs. p. 126; extracted from *Annales de Chimie*, iv. 85.

state of the atmosphere, which is found to be the fact. Adolescents too, who possess a great stock of accumulated excitability, will, on their systems becoming highly oxygenated, be more lively and sprightly than elderly persons, who, on the contrary, from a deficiency of excitability, are more apt to be melancholic. So also will this oxygenous principle, acting upon the vital medullary system of young people, explain why they are more subject to fevers of the order of phlegmasiæ, as well as to consumptions; while those of advanced years labour under indigestion, &c. and many diseases of the class of neuroses; partly from a worn-out excitability, and partly from a deficiency of the vivifying and invigorating stimulus that oxigene affords.

CURE.

THE cure of consumption, if what has been advanced be founded in truth, must depend upon a renewal of the substance or substances that the system is supposed to have lost: and that carbone or charcoal is the principal absent material in phthisis, which forms the connection or bond of union between the other ingredients, shall be endeavoured to be made apparent by the numerous facts which we shall now consider.

It appears that carbone is the principal lost material constituting our flesh and fat, not only by the analysis already related, but also from the great debility, and on the contrary from the increase of strength observable when it is so exhibited as to re-enter, and form again a considerable

considerable proportion of our fleshy fabric; and it seems to be by the agency of the same material that the present complaint is either palliated or removed, even when ulceration of the lungs takes place: it would also appear to be on this doctrine of carbonating the system, that we are to explain the popular opinion of longevity being most frequent, and the benefit patients in phthisis experience by living in places where this gas is abundant.* It is even said too, there have been instances of people in confirmed consumption being entirely cured by occupations where this gas is considerably evolved, such as from lime-kilns, breweries, tanneries, &c. &c.

That carbonic acid gas has been beneficial in consumption, receives further corroboration from the experiments of Percival, who, having exhibited it to many of his phthisical patients by way of respiration, says, “the hectic fever has in several instances been generally abated, and the matter expectorated has become less offensive and better digested.”† This operation of the gas may perhaps yield an easy explanation;—on inspiration it may have a power of diminishing the irritability of the lungs, which it may effect by absorbing a large proportion of their oxigene, which has been considered above as constituting this quality; and also, on
being

* 1 Percival's Eff. p. 460.—It is said, that consumptive patients in Germany are ordered to be placed in stables, among their horses, cattle, &c. from which practice they experience great relief: and on the same principle are we to explain the benefit such patients have received from the burning of resins, &c. in close apartments.

† 1 Eff. p. 308; and 1 Priestley, &c. p. 301. Append.

being received into the system, there will be a fixation of a part of it, and as the oxigene will be as it were neutralized, the presence of it will thus be no longer active. It will also operate beneficially by reducing the quantity of pure gas inhaled at each dilatation of the lungs, and consequently diminish the quantity of the principle of acidity derived to the blood and thence to the solids and secreted humours, from that source.

While this process is going on, or as the system shall become again more carbonated, there will of consequence be an alteration in the purulent matter through which the gas is received; and this too seems to be by the pus there formed possessing a more fluid or having a less tenacious consistence, and being more offensive before than after the exhibition of this remedy: the operation of the carbonic acid gas, then, in these last symptoms, is probably by its becoming united with part of the hydrogen, which before was not wholly combined with the small quantity of carbone forming the purulent compound; but its now becoming united with the super-abundant hydrogen, the pus will take on a more tenacious and firm consistence; and in proportion as this shall be effected will the offensiveness of expectoration diminish; for it would seem, that the great quantity of caloric at first carried by the oxigene in a state of combination, and there partly extricated, should easily volatilize the hydrogen, azote, and other substances with which they were united, and which were probably in such slight attachment that they might be easily decomposed, and forming other combinations, such as
phosphorated

phosphorated or carbonated hydrogen gas, &c. be thus volatilized by the agency of thermometric caloric. This being the case, while circumstances continue in the above situation, the pus must naturally be changed when the carbonic acid gas shall be exhibited, which requires a greater quantity of caloric to suspend it than the other gases, and which, when it shall combine as already mentioned and render the discharge more fixed, must of necessity prevent any further decomposition, and will cause it to be a more mild and digestive pus. This may also with equal propriety hold good with ulcers on the external surface of our bodies, which are well known to receive much injury from exposure to air; and as the good effects of applications to them, containing the *elements* by which this gas is formed, have long been experienced, it may not, perhaps, be unworthy of trial to expose such ulcers to an atmosphere of this gaseous fluid.

But the inspiration of the carbonic acid gas is not the only way by which the system may regain its lost ingredient, for it may also be received, and possibly with more effect, from such substances being taken for food or drink as contain it, viz. animal food, malt liquors, &c. all of which possess but a small quantity of the oxygenous principle: and hence, by the employment of this diet, the carbone, azote, &c. of which they are composed, may easily be received into the system by the operation of the chylopoietic viscera.

That this treatment is just and proper is further confirmed by the experience of convalescents and emaciated persons,

persons, who sometimes grow fat even to obesity, unless there should exist some mesenteric obstruction. This increase of corpulency may not unlikely be effected by means of the hydrogen that still remained in the emaciated habit, which, upon the admission of a fresh supply of carbone, united with it and formed the sebaceous compound; and this may have been the case with those persons who recovered from the yellow fever in Philadelphia, many of whom, it has been said, were observed to increase in fatness.

Consumption, however, may not be the only disease, for hæmoptysis itself would likewise seem in a considerable degree explainable on the doctrine of a hyper-oxygenation of the system, without having recourse to the ordinary way of attributing it chiefly to a *mechanical incapacity* of the respiratory organs, or to an *arterious plethora*; and this receives considerable support from patients in hæmoptysis being subject “to much sensibility and irritability”—the *ingenium præcox* Boerhaavii—as also from the inflammatory diathesis that generally prevails, from the heat and sense of pain in the breast, from the floridity of the blood, redness and flushings of the cheeks, &c. all which seem to corroborate the analogy between the two diseases; and as they so constantly concur in each, a conclusion might be inferred, that hæmoptysis should be considered as an *incipient* phthisis.

This explanation of hæmoptysis likewise receives further confirmation from the known good consequences that result in part from the same plan of cure; such

as sea-voyages, which seem to have been known even in the time of Pliny, as he says, “for the phthific or consumption there is nothing so good as to sail or be rowed upon the water, especially upon the sea;”* and the same naturalist, in another place, speaks more directly in point, as appears from the following observation he makes:—“The sea (says he) affordeth other uses in several and many respects; but principally its air is wholesome to those that are in a phthific or consumption, as I have before said, and cureth such as reach and void blood upwards: and truly, I remember of late, that Annæus Gallio, after he was made consul, took this method, namely, to sail upon the sea for that infirmity. What think you is the cause that many make voyages into Ægypt? Surely it is not for the air of Ægypt itself, *but because they lie long at sea*, and are sailing a great while before they arrive thither.”†

These facts of Pliny’s are constantly confirmed by the daily experience of mariners, who are seldom or never subject to consumption. The good effects of navigation, however, do not appear to arise entirely from the air of the sea, but also from the provision used during the voyage, which is that of the animal kind; and hence probably the reason, together with the little exercise they take, why mariners are more corpulent than men who live on shore; for this species of food not only produces corpulency, but also a scorbutic state of the system, which, with the impurity of the air of-
tentimes

* Nat. Hist. tom. i. lib. 28. cap. 4. E.

† Lib. 31. cap. 6. L.

tentimes below and between decks, affords less of the respirable portion to the lungs in each inspiration: and since ships, by means of Dr. Hales, have been so ventilated that the air may have a free passage through them, the scurvy, which before made such ravages, has been less frequent in its appearance and less fatal in its effects.

Since, from all that has been said, it is clearly evident, that both hæmoptysis and phthisis are induced according as there shall be present an *excess* of the principle of acidity in the system, then certainly all those means by which the system may become super-oxygenated should be avoided, as also the administration of those substances which have a great attraction for it, such as iron, &c.*

May it not be asked, whether the ordinary management of patients in either of these complaints, and the success attending them, shew that they are treated after a method suitable to their cure? Daily experience demonstrates the contrary—hence, we should no longer advise patients so afflicted to hasten to breathe the country air, already made too pure by vegetable extrication; nor to diet upon vegetables and milk, or to make use of acidulous drinks;† but to pursue the direct contrary method above laid down, if they would wish for a radical solution of the disease: nor should the exercise of equitation, &c. so much boasted of in these

* May it not in a great degree be owing to the presence of iron that some mineral waters are hurtful to consumptive patients?

† Sub-acid liquors alone, it is said, have induced consumption, as has been experienced by some ladies, who, wishing to appear more than what they supposed ordinarily delicate, have made great use of vinegar, lemonade, &c.

these affections, be implicitly relied upon, as it is very probable they seldom or never do good without the intervention of some other circumstances not properly attended to, and which are agreeable to the doctrine above expressed: thus the aborigines of our country have scarcely ever been observed to be affected with consumption, which may easily be accounted for, not from the exercise they take, but by their living in damp woods and sleeping on the ground, where they respire less pure air, which last alone has been said to cure the disease.* This, however, is not the only thing: their food too, which is that of wild animals, contain considerable of the lost principle and but little of the oxygenous. So also may it be with agriculturalists, who not only live in a great measure upon animal food, but also receive the exhalations of the earth, by ploughing, &c. The riding on horseback, therefore, so much recommended by Sydenham and others, must certainly be hurtful on the single consideration of there being a larger volume of air exposed to the superficies of the lungs; and that this is injurious may also be sufficiently confirmed from the benefit consumptive patients receive in warm climates, where the air is not so condensed, and where consequently *cæt. par.* less is breathed.

The facts which have been related on the cause and cure of hæmoptysis and phthisis, will receive farther
corroboration

* Van Swieten, in his commentaries on Boerhaave, tells us, on the authority of Solano de Luque, of the successful practice of the *BANOS DE TIERRA*, or earth baths in hectic fevers and consumptions, in Grenada, Andalusia, and other provinces of Spain.

corroboration from the symptoms of the disease purposed to be next treated of, viz.

SCURVY.

Consumption may not only be explained on the causes above alledged, but also have a greater probability of truth, from the symptoms that are observed to exist in scorbutus; for in this disease, in which there is a *disoxygenated* state of the system, we do not discover that remarkable loss of fleshy matter, nor that hilarity of mind or floridity of the blood and fever, which are the sure concomitants of consumption: on the contrary, laxity and debility of the solids, paleness of the countenance, dark colour of the blood, and above all, a sadness and depression of spirits, appear sure pathognomonics of this complaint: all which symptoms, it shall be endeavoured to be shewn, depend very evidently upon a *redundancy* of carbone in the blood and solids, and upon a *deficiency* of the vivifying and invigorating stimulus of oxigene.

The despondency of mind which is always apparent in scorbutics, and which is so opposite to what prevails in consumption, would seem easily accounted for, by supposing the system to contain an *excess* of carbone, which shall attract, absorb or neutralize most of its oxigene; and in proportion as this shall be effected, will the production of direct debility, from the abstraction of so powerful a stimulus, *approach to death or non-existence of the quality of life*; for it would appear in truth, that the system in scurvy is as much and as strictly *super-*

per-carbonated, as in consumption it was said to be *super-oxygenated*.

The dark colour of the blood, the vibices and ecchymoma that make their appearance in scurvy, would, from what has been said on consumption, seem to be owing to an *abstraction* of the principle of acidity; and therefore, as is the disposition of the system to phthisis will the floridity of the sanguineous fluid appear; and of consequence, as there shall be a *deficiency* of the above floridifying principle, the materials entering the composition of the blood must exist nearly or quite in their natural state and colour: and this appears to happen in the disease under consideration.

As iron is the chief material entering this circulating fluid, to which, in a state of oxidation, it owes its florid appearance; so therefore must the iron re-assume its pristine state and colour, when this floridifying substance shall be withdrawn in any disease wherein substances shall be present which possess a greater affinity or attraction for it than the iron. This is remarkably elucidated in scurvy, in which there appears such an *excess* of carbonaceous matter as to abstract from the iron all its oxigene, and leave it nearly or perhaps quite in its reguline or metallic state. There is, however, another way of accounting for the dark colour of the blood, and which may possibly be more conclusive;—the carbone itself, in substance, may enter the circulating mass, and thus tinge it of different shades, in proportion to the degree in which it shall be present. This receives considerable confirmation from the observations made by

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Lord Anson's surgeons, who say, that "in the beginning of the disease the blood, as it flowed out of the orifice of the wound, might be seen to run in different shades of light and dark streaks. Where the malady was increased, it ran thin and seemingly very black; and after standing some time in a vessel, turned thick and of a dark muddy colour. In the third degree of the disease, it came out as black as ink. Lastly, as all other kinds of hæmorrhages were frequent at the latter end of the calamity, the fluid had the same appearance as to colour and consistence."

From this account it would appear, that oxigene is not only absent from the iron, but that the carbone itself is floating in the sanguiferous system, and thus the blood in the arterial is rendered of the same colour and composition which is exhibited by the venous blood in health; and hence the latter must be so fully carbonated as to lose its connection with the iron by this abstraction of the oxigene, which, when in just proportion, appears to be a cementing principle somewhat similar to that remarked by lithologists to exist in minerals. This being the fact, it will no long remain a wonder why vibices and dark coloured effusions appear in scorbutus.

The offensive breath (*dysodia pulmonica*) and the high colour of several of the excretions in scorbutics, seem also to arise from the new combinations that are formed on the decompositions above alluded to;—part of the hydrogen may unite with the azote and form an ammoniacal compound; or the azote may combine with a small proportion of oxigene in such a way as to form

form the oxyd of azote or nitrogene; or again, the hydrogen may combine with the phosphorus or carbone, and form phosphorated or carbonated hydrogen gasses; and it would seem to be by these different combinations variously modified, that not only the above symptoms of scurvy, but perhaps all cutaneous eruptions, diseases, or ulcers whatsoever, in which there appears to be an acrimony of the circulating fluids, such as scrophula, erisipelas, lepra, cancer, &c. are to be explained: and by these various modified combinations perhaps also every species of contagious matter whatsoever may be generated or produced in animal and vegetable bodies.

That scurvy is the direct effect of super-carbonation of the system, is further proved from the experience of those who are obliged to live principally upon animal food, especially that which is in a state of putrescence, which every one knows is already in an incipient decomposition, and hence may the more readily yield its carbone in the digestive process. Many more facts, however, might be adduced, if it were necessary, to support what has already been advanced concerning the tendency of animal food to induce scurvy; such, for instance, as what has been related by Sinopæus, who observes, “there are whole nations in Tartary, who live altogether on flesh and milk, and which people (says he) are subject to the most violent scurvies.”*

These are not the only causes to which scurvy has been attributed, for many consider cold and moisture as
highly

highly conducive to the disease. These opinions, however, are considerably doubtful, unless they should be conceived as inducing their ill effects in the way Sanctorius asserts; “for (says he) too cold windy or wet weather lessens perspiration;”* and the perspiration being thus obstructed, he goes on—“it converts the matter of transpiration into an ichor, which being retained, induces a cachexy.”† Sanctorius appears somewhat just in his conclusions, by supposing and describing what he thought humidity of the air as favouring the disease, which conclusions he drew from his statical experiments, wherein he further relates, concerning this obstructed excretion in scurvy, “that here perspiration is stopped, the passages of it clogged, the fibres are relaxed; and the transpiration of it retained proves hurtful.”‡ But these latter assertions of Sanctorius can only be partially admitted as causes of scorbutus; for it would appear, that cold air was not *alone* the cause, but if any thing rather beneficial, agreeable to what has been already observed on consumption, in which complaint experience gives great attestation in favour of a warm climate; and for directly contrary reasons must it be beneficial in this, because of there being a greater quantity of oxigene air received into the system by ordinary respiration in a cold climate, where the atmosphere is more condensed, than in a warm one, where it is more rarified: and consequently the system will stand

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* Medicina Statica. aph. 200.

† Ibid. aph. 146.

‡ Ibid. aph. 148.

a greater chance of becoming oxygenated in the former than in the latter.

As to the obstructed cuticular or pulmonic exhalations being considered another cause of scurvy, these likewise would not seem altogether satisfactory, unless the system should be in a state of *predisposition*, by being already *super-carbonated*, and then all that experienced man has said may be admitted; for in this state of super-carbonation, when the cuticular excretion shall be obstructed and retained, will all the substances the perspirable vapour contained become in some degree fixed, or form other combinations.

As it appears that carbone is a prevalent ingredient of the fleshy parts of our bodies, it consequently must exist also in a considerable proportion in the above excretion; and that this is fact, has been proved by the experiments of the Count de Milly and others, who have collected large quantities of carbonic acid gas during its evolution from the surface of the body: this gas, then, being retained in the system, is very obviously an additional help to a disease depending upon too much of the same material. This explanation is further conclusive on the consideration that obstructed perspiration is not alone, but that *super-carbonation* of the system is also a cause of scurvy; and this is agreeable to the above observation of Sinopæus; for the food of those people, although they lived near the frigid zone, yielded the noxious material.

The doctrine of super-carbonation of the system is still further strengthened from there appearing no febrile heat

heat in scurvy, which is known to exist, in a considerable degree, in phthisis; as also from the circulation being languid, and from the torpor and debility of all the functions,—vital, animal and natural, which fully demonstrate a deficiency of the vivifying power of oxygen.

The Deliquia, too, attending scurvy, seem strongly to argue the deleterious agency of carbone, when it exists *internally*, as well as when it is applied *externally*, in the state of gas, in too great quantities, to parts possessing much irritability; as it may, by its *direct* internal application to the vital “medullary nervous matter and muscular solid,” abstract from them the principle that gave them irritability; and hence, in proportion to the degree in which this application shall be made, will the state of inanimation, or the torpor and debility of the solids, whether vital or animal, be produced; and this abstraction of the oxygenous principle, if carried to the greatest degree, will, by inducing *direct debility*, cause *cessation of animal existence altogether*, and this as effectually as in the opposite state of the system, when, by the too great presence of the oxigene, the animal is *stimulated to death*.

That the carbonaceous principle, when in too great accumulation in the system, possesses a power of extinguishing its susceptibility of stimuli altogether, is a fact clearly demonstrated by the weakness and feebleness of the pulse, by the whole system of solids being in a weakened and relaxed condition, and even by the putridity of the heart itself.*

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The conclusion, then, from all that has been delivered, seems clearly apparent, that scurvy originates from the same causes both upon land and sea, and appears to be the same disease ever since the first account we have of it on the latter by Vasco de Gama;* and therefore, “if the axioms for the study of nature, in the material inanimate world, be also applicable to the various modes of life and organization,” then we may understand why “effects of the same kind may be ascribed to the same causes; and the qualities of phænomena discovered by experiments, may be considered as universal qualities of phænomena of the same kind,” in diseases of the human constitution, as well as in other cases.

To put the matter, however, beyond the possibility of doubt, that they are both induced by the same identical cause, viz. super-carbonation of the system, the method of cure will in both appear to be the same, that is, exactly similar to the common practice which induces consumption.†

CURE.

FROM the foregoing observations, scorbutus appears to be a disease existing only in proportion as the system

* See the History of the Portuguese Discoveries, &c. by Herman Lopez de Castaneda.

† That the symptoms of scurvy above enumerated are positive facts may beevinced from considering the case of the *PUER CÆRULEATUS* of Sandifort, as related in the “*Observationes Anatomico-Pathologicæ*, Lugd. Batav. 1777, p. 11. & seq.” which case is also quoted by Beddoes, in his “*Observations on the Nature and Cure of Calculus, Sea-Scurvy*,” &c. p. 63, but which is too lengthy for insertion in a publication of this kind.

system shall be carbonated, or as it shall be in a condition opposite to that which exists in consumption, and therefore, to obtain a radical cure, must necessarily be treated by contrary remedies.

The first and most powerful remedy calculated to effect a speedy cure appears to be that of oxigene air, received by respiration; and this will the more fully be understood, when we consider that it is the only "*breath of life*," as all the other gasses either cannot support, or immediately destroy the *living quality* of organized matter. As this is a condition of the system in which *life* approaches nearly to a state of *non-existence*, that nourishing principle or support of life is therefore required which the ancients denominated *pabulum vitæ*; for Hippocrates positively says, "*Principium alimenti spiritus*."* This *pabulum vitæ*, or *breath of life*, then, which is *essential* to animal existence, we find in the base of oxigene air, the operation of which animating stimulus, as soon as it is received into the system of patients in this moribund complaint, will, on its decomposition, diffuse heat, life and vigour throughout the constitution.

Next to this *empyrean* gas, which is proved to possess the *only* principle by which the quality of animation can be excited in organized matter of the human type, possessing a susceptibility of its stimulus, we should seek for those substances that contain the oxygenous principle in the greatest quantity, having at the same time such a slight attachment for it, that this *animating*
stimulant

* Hippocrat. de Alim. v. 68.

stimulant may be disengaged, and thus enter the system by the *primæ viæ*, as well as when it is received in the manner above expressed.

It has been observed, that some of the mineral acids do not cure the scurvy so speedily as the acetous, citric, oxalic, tartaric, &c. this, however, is easily understood, for the oxigene in those acids appears to be in such firm combination with their radicals as not to suffer decomposition like the vegetable class.

Of all vegetables the Citrus stands first on the list in the cure of this dismal and deadly disease; and it is to this alone that Lord Anson attributes the cure of his men in the island of Tinian, as well as many others who highly extol it;* and it is upon this that Kramer solely relies.†

The citrus having been long experienced to be more beneficial than any other vegetable substance, may be owing to its containing a larger proportion of oxigene, and less of carbone, azote, &c. than other plants; and this appears to be the reason why those also of the Tetradynamous class are greatly recommended; for the small proportion of azote, &c. they are found to possess, is far more than compensated for by their exuberance of oxigene.

Scurvy, however, would not appear to be the only disease occasioned by an hyper-carbonated state of the system, for many others, especially those belonging to the class of Neuroses, seem to depend upon a want of the

* Mead's Discourse on the Scurvy, p. 111.

† Krameri Medicina Castrensis, part iii. cap. 2.

the vivifying stimulus that oxigene affords; such, for instance, are paralysis, syncope when it arises from direct debility, dyspepsia, hypochondriasis, chlorosis, tetanus, trismus, convulsio, chorea, epilepsia, asthma, dyspnœa when it arises from debility or paralysis of the muscles of the larynx, cholera, chronic diarrhœa, hysteria, hydrophobia, amentia, melancholia, and cholera infantum, &c. which last seems to be almost positively confirmative of this doctrine; for “out of many hundred children,” says Rush,* “whom I have sent into the country in every stage of this disorder, I have lost only three;” two of which, the Dr. says, did not follow his directions; and he proceeds—“it is extremely agreeable to see the little sufferers revive, as soon as they escape from the city air and inspire the pure air of the country.” A fact of the same nature was related to me by Professor Smith, whose child was very ill of this disease, and grew better on his leaving this city to go with it to New-Jersey: the passage was at night, and consequently the air more condensed: the infant, which was carried in his arms in the open air, was well clothed to prevent the ill effects that might perhaps have arisen from the application of cold air to the surface of its body, so that the face only could be exposed, and hence the operation of the air could only have been on the *respiratory organs*.† That the cure depends upon the influence of oxigene is further evident from the use of acids, especially the vegetable; for Professor Smith had

two

* i. Med. Inq. p. 118.

† Many more facts might be adduced of the beneficial effects of country air from the observations of Professors Hamersley, Rodgers, &c.

two patients that were immediately cured by the use of the acetous acid,* a proportion of which was taken without his knowledge, and the cure effected much to his surprize. Vegetable acids probably operate in the way related of them in the cure of scurvy.

All the symptoms of typhus seem also evidently to depend upon its absence; and it is highly probable, if oxigene air should be administered by way of respiration, there would be happy consequences arising from its exhibition; and this is rendered evident from the common practice of hanging up or placing young and vigorous plants in the apartments of those labouring under the disease; for such plants not only perspire a large quantity of vital gas, but also inhale the mephitic. The efficacy of acids also, especially the vegetable, as possessing the property above related, is likewise to be accounted for on the same principle.

On the contrary, the class of Cachexiæ, as well as that of Phlegmasiæ, may depend upon an *excess* of oxigene; as, anasarca, ascites, hydrothorax, &c. in which diseases the oxigene may combine with the hydrogen, and form the serous fluids observable in them; and hence, for contrary reasons, the inspiration of carbonic acid and hydrogen airs must be very serviceable. The remarkable loss of fat in the omentum, viscera, &c. renders it still more probable that these diseases depend upon a too high oxygenated system.

Should what has been advanced hereafter prove true, it would seem necessary that a new Nosological arrangement

* Perhaps the acid may have had a physiological as well as a chemical action.

arrangement of diseases should be formed, and classed, according as they are induced, either by an excess of oxygenation, or by the different ratios of proportion which the several ingredients, oxigene, hydrogene, carbone, iron, &c. bear to each other in our constitutions.

It may not be improper here to observe, that if, in the living human body, (and all others, perhaps) decompositions and new combinations shall take place, as has been above endeavoured to be made apparent, then it may not be difficult to conceive that the Humoral Pathology, which has of late been in some measure exploded, shall receive some cogent arguments in its favour; for, according as the above related decompositions and new combinations shall ensue, will great alteration take place in the circulating humours, which in their *peccant* proportions may induce diseases and death; and the correction and adjustment of the proportions of which is unquestionably, in many cases, one of our rational indications of cure.

In tracing *all* diseases, therefore, to the solids alone, as Milman has done, (who seems almost to have considered the fluids *as useless parts* of the constitution) there is certainly a radical error.

Since, therefore, decompositions and new combinations, variously modified, are constantly taking place throughout *animate* as well as *inanimate* matter, and of which we have such manifold experience, it would seem, that a doubt could scarcely rest with any one, that each and every of us, have, or shall participate of the different modes of existence that matter, organized or

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inorganized,

inorganized, assumes in the different grades of creation
 —from man to the lithophyte,*—from “the cedar that is
 in Lebanon to the hyssop that springeth out of the wall,”
 —from the mite to the elephant:—thus substantiating
 the sayings made of old—

——“ Quocumque flexeris te, habebis ibi DEUM
 occurrentem tibi: nihil vacat ab illo, ipse implet opus
 suum.”——

——“ JUPITER est quodcunque vides, quocun-
 que moveris.”——

- “ The system one, one Maker stands confess'd;
- “ The prime, the one, the wond'rous and the blest;
- “ The one on *various forms* of UNITY express'd.”

* “ Thou almost mak'st me waver in my faith
 To hold opinion with Pythagoras,
 That souls of animals infuse themselves
 Into the trunks of men.”

F I N I S.

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